

# PATENT ABSTRACTS OF JAPAN

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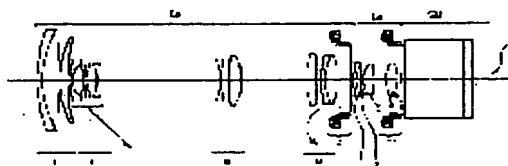
(72)Inventor : HORIUCHI AKINAGA

## (54) REAR CONVERTER LENS AND CAMERA PROVIDED THEREWITH

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a rear converter lens having excellent optical performance while securing specified back focus in spite of simple constitution.

**SOLUTION:** This rear converter lens Lc is attached to the image side of a principal lens system Ls, displaces the focal distance of an entire system to an enlargement side and has negative refractive power as a whole. It is provided with a 1st negative lens 1 whose strong concave surface relatively faces to the image side, a combined lens obtained by sticking a 2nd negative lens 2 whose strong concave surface relatively faces to the image side and a 3rd positive lens 3 whose strong convex surface relatively faces to an object side, and a combined lens obtained by sticking a 4th positive lens 4 whose both surfaces are convex and a 5th negative lens 5 in order from the object side.



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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is attached in the image side of the main lens system removable, and relates to the rear converter lens which carries out the variation rate of the focal distance of the whole system to a looking-far side.

[0002]

[Description of the Prior Art] From before, in an one eye reflex camera, it equips with a lens system with negative refractive power between an interchangeable lens and a film plane, and the adapter which carries out the variation rate of the focal distance of the whole system to a looking-far side is known. For example, such a rear converter lens is indicated by JP,51-12421,B and JP,61-13206,B.

[0003] On the other hand, recently, high definition-ization of a video camera is progressing with high-performance-izing and digitization of a videocassette recorder. As one method of attaining high definition-ization of a video camera, photography light is made decomposition according to color-separation optical system at each colored light, and the method of capturing an image with three image sensors is learned.

[0004] In the video camera equipped with color-separation optical system, although the thing which can exchange taking lenses is known, there is a demand of wanting to also equip such a video camera with the above-mentioned rear converter lens.

[0005]

[Problem(s) to be Solved by the Invention] However, if a certain amount of back focus is not secured in order to apply a rear converter lens to the video camera which has color-separation optical system, a converter lens interferes in optical members arranged ahead of image pick-up sides, such as CCD, such as color-separation optical system and an optical low pass filter, and there is a problem that wearing becomes impossible.

[0006] Moreover, in order that the main lens system equipped with a rear converter lens may take a photograph by itself, good aberration amendment has already been performed by the simple substance. However, if the main lens system is equipped with the rear converter lens which has the above negative refractive power, since the PETTSU bar sum will become negative, in proportion to the magnitude of a field angle, the image surface will become exaggerated, and image quality will deteriorate.

[0007] Although it is possible to amend many aberration by increasing lens number of sheets consequently, the dimension of the whole system including the main lens system increases, and the problem that a lens configuration will be complicated arises.

[0008] This invention is made in order to solve the above-mentioned problem, and it aims at offering the rear converter lens which can maintain good optical-character ability, securing a predetermined back focus, though it is a compact configuration.

[0009]

[Means for Solving the Problem] In the rear converter lens of the negative refractive power as a whole which the image side of the main lens system is equipped [ refractive power ] with this invention, and carries out the variation rate of the focal distance of the whole system to an expansion side in order to attain the above-mentioned purpose The 1st negative lens to which the concave surface relatively strong against an image side was turned in order [ side / body ], It is characterized by having the cemented lens which stuck the 2nd negative lens to which the concave surface relatively strong against an image side was turned, and the 3rd forward lens to which the convex relatively strong against a body side was turned, and the cemented lens with which both sides stuck the 4th convex forward lens and the 5th negative lens.

[0010]

[Embodiment of the Invention] The operation gestalt of this invention is concretely explained using a drawing.

[0011] Drawing 1 , and 3 and 5 are the lens sectional views at the time of attaching the rear converter lens of the numerical examples 1-3 later mentioned to the image side of the main lens system (zoom lens), respectively, and drawing 2 , and 4 and 6 are the aberration Figs. of the whole system at the time of attaching the rear converter lens of the numerical examples 1-3 in the zoom lens for photography, respectively. In drawing 2 , and 4 and 6, an aberration Fig. [ in / in (a) / a wide angle edge ], an aberration Fig. [ in / in (b) / a middle focal distance ], and (c) express the aberration Fig. in a tele edge. Moreover, in drawing 2 , and 4 and 6, d and g express  $\delta M$  and d line, g line, and  $\delta S$  express the

meridional image surface and the sagittal image surface.

[0012] In drawing 1, and 3 and 5, the zoom lens with which Ls is constituted by 1-4th lens group I-IV, and Lc are the image pick-up sides where, as for a rear converter lens and GB, glass blocks, such as color-separation prism, a face plate of CCD, and a low pass filter, should be arranged, and, as for I, image sensors, such as CCD, should be arranged. Especially with this operation gestalt, the image sensor with a screen size of 3.6x4.8mm (usual picture area size 6.0mm:1/3 inch CCD) is assumed to 3CCD digital camcorder used three sheets. That is, in drawing 1, and 3 and 5, although, as for the image pick-up side I, only one is drawn for simplification, corresponding to each color, three image pick-up sides will exist in fact.

[0013] The body of a camera is equipped with the rear converter lens Lc and the rear converter lens Lc for the zoom lens Ls through mounting member C' through the mounting member C. Therefore, an image side is contained in the body of a camera from a glass block GB. In addition, in drawing 3 and 5, although the mounting member C and C' are omitted, it is the same configuration as drawing 1.

[0014] In this operation gestalt, while a zoom lens Ls moves the 2nd lens group II to an image side like the arrow head shown in each drawing on the occasion of the variable power from a wide angle edge to a tele edge, it moved the 4th lens group IV and has amended the image surface fluctuation accompanying variable power. Moreover, it is the zoom lens of rear focus \*\*\*\* which is moved on an optical axis in the case of a focus, and performs the 4th lens group IV at it.

[0015] The rear converter lens Lc of this operation gestalt constitutes the 1st lens 1 from a negative lens, in order to lengthen a back focus, and it is making it retro focus type lens arrangement. However, if negative power of the 1st lens 1 is strengthened recklessly, since the PETTSU bar sum will become large negative and the image surface will become exaggerated (an exaggerated curvature of field occurs), a positive lens is arranged from the 2nd lens 2 before the 5th lens 5, the assignment of the power of each lens is made small, and effective reduction of a curvature of field is aimed at.

[0016] Moreover, in a common rear converter lens, there is the description of worsening the aberration generated with the main lens only the square twice of the scale factor of a rear converter lens. When a rear converter lens is used for the camera which has attained high definition by disassembly of the image by color-separation optical system like this operation gestalt, chromatic aberration needs to be amended more by fitness. For this reason, the rear converter lens of this operation gestalt has amended chromatic aberration good with the cemented lens.

[0017] Although the purpose of this invention is attained by constituting a rear

converter lens like the operation gestalt which is a \*\*\*\*, in order to perform still better aberration amendment, it is desirable to satisfy at least one of each items of (a) - (f) described below.

[0018] (a) time of setting the focal distance of D34 and a rear converter lens to  $f_c$  for air spacing of the 3rd lens and the 4th lens which constitutes a rear converter lens  $0.01 < -- |D34/f_c| < -- 0.05$  (1)

Satisfy the becoming conditional expression.

[0019] Conditional expression (1) is the conditions for amending astigmatism and distortion aberration with sufficient balance. An astigmatism gap becomes large and is not desirable if the upper limit of conditional expression (1) is exceeded. On the contrary, if a lower limit is exceeded, while amendment of distortion aberration will become difficult, the overall length of a rear converter lens becomes short too much, spacing of the main lens and a camera runs short and it becomes difficult to arrange a rear converter lens physically.

[0020] (b) time of setting to  $\nu_4$  and  $\nu_5$  the Abbe number of the quality of the material of the 4th lens which constitutes a rear converter lens, and the 5th lens  $21 < -- \nu_4 - \nu_5 < -- 50$  (2)

Satisfy the becoming conditional expression.

[0021] Conditional expression (2) is the conditions for amending the chromatic aberration generated with a rear converter lens good. If the upper limit of conditional expression (2) is exceeded, axial overtone aberration will become exaggerated and it will become superfluous amending it. On the contrary, if a lower limit is exceeded, axial overtone aberration will become an undershirt and it will become insufficient amending it.

[0022] (c) time of making into the object point of a rear converter lens the image point formed only of the main lens system, setting to  $L$  (air scaled distance) distance with the image point which is a point [ \*\*\*\* ] formed with a rear converter lens, and setting usual picture area size to  $Y$  (3)  $2.2 < -- L/Y < -- 4.6$

Satisfy the becoming conditional expression.

[0023] Conditional expression (3) is related to the overall length (magnitude) of a rear converter lens. If the upper limit of conditional expression (3) is exceeded, the overall length of a rear converter lens causes [ become large and ] enlargement of the whole lens and is not desirable. On the contrary, if a lower limit is exceeded, the overall length of a rear converter lens will become short too much, and it becomes difficult for spacing of the main lens and a camera to approach and to arrange a rear converter lens physically.

[0024] In addition, the usual picture area size  $Y$  is the size of drawing 1 and the image pick-up side  $l$  in 3 and 5. Generally, since the image pick-up side  $l$  is a rectangle, as for the usual picture area size  $Y$ , it is expressed with the diagonal line

length. In this operation gestalt, the usual picture area size Y is 6.0mm, as mentioned above.

[0025] (d) time of setting the radius of curvature by the side of R12 and the body of the 2nd lens to R21 for the radius of curvature by the side of the image of the 1st lens  $0.03 < -- |R12/R21| < -- 0.11$  (4)

Satisfy the becoming conditional expression.

[0026] In order to amend spherical aberration and comatic aberration with sufficient balance and to make a back focus into a suitable value especially, it is good to satisfy conditional expression (4). If the upper limit of conditional expression (4) is exceeded, while comatic aberration will become large, back focuses run short. Conversely, spherical aberration becomes an undershirt and is not desirable if a lower limit is exceeded.

[0027] (e) time of setting  $N_p$  and the average refractive index of the quality of the material of a negative lens to  $N_n$  for the average refractive index of the quality of the material of a positive lens among the lenses which constitute a rear converter lens  $1.39 < -- N_p < -- 1.65$  (5)

$1.55 < N_n < 1.91$  (6)

Satisfy the becoming conditional expression.

[0028] It is the conditions for conditional expression (5) and (6) using low refractive-index glass for the positive lens of the lens which constitutes a rear converter lens, using high refractive-index glass for a negative lens, and preventing aggravation of the PETTSU bar sum, and if the quality of the material of a refractive index with which conditional expression is not filled is used, a curvature of field will get worse.

[0029] (f) In order to amend the flare besides still better aberration amendment, especially a shaft good, use at least one aspheric lens for a rear converter lens.

[0030] In addition, it is desirable that it is the configuration to which forward refractive power becomes weak as an aspheric surface configuration goes to the periphery of a lens.

[0031] Next, the numeric data of the zoom lens shown in drawing 1 -3 and the rear converter lens of the numerical examples 1-3 is shown. The numeric data of a zoom lens is common in each numerical example.

[0032] each numeric data -- setting --  $r_i$  -- a body side -- order -- the  $i$ -th lens thickness and air spacing, and  $n_i$  and  $n_{ui}$  are the radius of curvatures of the  $i$ -th field, and  $d_i$  is the refractive index and the Abbe number of the  $i$ -th lens in order from a body side in a body side, respectively.

[0033] The field number in the numeric data of a rear converter lens is a field number counted also including the lens side of a zoom lens. Therefore, d25 expresses spacing with the last side (the 25th page) of the main zoom lens. On the

other hand, the members expressed with the 34-36th page are drawing 1 and the glass block GB shown in 3 and 5.

[0034] Moreover, it is [0035], when an aspheric surface configuration makes [ the direction of an optical axis ] the travelling direction of H shaft and light forward for the X-axis, an optical axis, and a perpendicular direction in each numeric data and paraxial radius of curvature and each aspheric surface multiplier are set to K, B, C, D, E, and F for r.

[External Character 1]

$$X = \frac{(1/r)H^2}{1 + \sqrt{1 - (1+K)(H/r)^2}} + BH^4 + CH^6 + DH^8 + EH^{10} + FH^{12}$$

It expresses with the becoming formula.

[0036] The display of "e-Z [ moreover, ]" means "10-Z."

[0037]

[External Character 2]

主レンズ系 (撮影レンズ)

| f=5.65~90.91    |            | f <sub>∞</sub> =1:1.65~2.70 |            | 2ω=55.9° ~3.8° |  |
|-----------------|------------|-----------------------------|------------|----------------|--|
| r 1= 66.535     | d 1= 1.70  | n 1= 1.84566                | ν 1= 23.8  |                |  |
| r 2= 40.775     | d 2= 5.85  | n 2= 1.49700                | ν 2= 81.6  |                |  |
| r 3= -265.614   | d 3= 0.20  |                             |            |                |  |
| r 4= 36.348     | d 4= 3.20  | n 3= 1.69680                | ν 3= 55.5  |                |  |
| r 5= 90.440     | d 5= 可変    |                             |            |                |  |
| r 6= 40.256     | d 6= 0.90  | n 4= 1.88300                | ν 4= 40.8  |                |  |
| r 7= 8.742      | d 7= 3.63  |                             |            |                |  |
| r 8= -31.100    | d 8= 0.80  | n 5= 1.88300                | ν 5= 40.8  |                |  |
| r 9= 80.646     | d 9= 0.60  |                             |            |                |  |
| r10= 17.012     | d10= 3.10  | n 6= 1.84566                | ν 6= 23.8  |                |  |
| r11= -35.698    | d11= 0.30  |                             |            |                |  |
| r12= -22.871    | d12= 0.80  | n 7= 1.77250                | ν 7= 49.6  |                |  |
| r13= 48.797     | d13= 可変    |                             |            |                |  |
| r14= 0.000 (絞り) | d14= 4.02  |                             |            |                |  |
| r15= -20.418    | d15= 1.00  | n 8= 1.77250                | ν 8= 49.6  |                |  |
| r16= -85.604    | d16= 2.01  |                             |            |                |  |
| *r17= 66.884    | d17= 4.60  | n 9= 1.58313                | ν 9= 59.4  |                |  |
| r18= -20.646    | d18= 22.81 |                             |            |                |  |
| *r19= 28.893    | d19= 3.70  | n10= 1.58313                | ν 10= 59.4 |                |  |
| r20= -163.671   | d20= 1.70  |                             |            |                |  |
| r21= 62.365     | d21= 1.00  | n11= 1.84566                | ν 11= 23.8 |                |  |
| r22= 21.910     | d22= 4.60  | n12= 1.48749                | ν 12= 70.2 |                |  |
| r23= -33.114    | d23= 可変    |                             |            |                |  |
| r24= 0.000      | d24= 1.60  | n13= 1.51633                | ν 13= 64.1 |                |  |
| r25= 0.000      |            |                             |            |                |  |

| 焦点距離<br>可変間隔 | 5.65  | 19.05 | 90.91 |
|--------------|-------|-------|-------|
| d 6          | 0.65  | 23.38 | 38.53 |
| d 14         | 39.89 | 17.16 | 2.01  |
| d 23         | 22.81 | 18.36 | 23.06 |

\*は非球面  
非球面係数

R17: <sup>k</sup> 2.08245D+01 <sup>B</sup> -3.13644D-05 <sup>C</sup> -2.62003D-08 <sup>D</sup> -1.75203D-11 <sup>D</sup> 5.80604D-14

R19: <sup>k</sup> 6.07450D+01 <sup>B</sup> -1.84740D-05 <sup>C</sup> 8.30556D-09 <sup>D</sup> -6.38554D-11 <sup>D</sup> 7.26711D-15

[0038]



### [External Character 3]

リアコンバーターレンズ

数値実施例1

|      |          |      |       |      |         |      |      |
|------|----------|------|-------|------|---------|------|------|
| r26= | 47.231   | d25= | 0.88  | n14= | 1.69680 | v14= | 55.5 |
| r27= | 18.808   | d26= | 1.20  |      |         |      |      |
| r28= | -426.932 | d27= | 1.31  | n15= | 1.69680 | v15= | 55.5 |
| r29= | 11.044   | d28= | 1.20  | n16= | 1.60342 | v16= | 38.0 |
| r30= | 58.249   | d29= | 3.20  |      |         |      |      |
| r31= | 16.004   | d30= | 4.58  | n17= | 1.48749 | v17= | 70.2 |
| r32= | -23.739  | d31= | 4.00  | n18= | 1.80610 | v18= | 40.9 |
| r33= | -63.009  | d32= | 1.00  |      |         |      |      |
| r34= | 0.000    | d33= | 2.00  | n19= | 1.58913 | v19= | 61.1 |
| r35= | 0.000    | d34= | 20.00 | n20= | 1.51633 | v20= | 64.2 |
| r36= | 0.000    | d35= | 3.75  |      |         |      |      |

[0039]

### [External Character 4]

リアコンバーターレンズ

数値実施例2

|      |          |      |       |      |         |      |      |
|------|----------|------|-------|------|---------|------|------|
| r26= | 51.668   | d25= | 1.71  | n14= | 1.69680 | v14= | 55.5 |
| r27= | 18.028   | d26= | 1.20  |      |         |      |      |
| r28= | -257.639 | d27= | 2.13  | n15= | 1.69680 | v15= | 55.5 |
| r29= | 9.745    | d28= | 1.20  | n16= | 1.60342 | v16= | 38.0 |
| r30= | 64.837   | d29= | 3.20  |      |         |      |      |
| r31= | 15.456   | d30= | 3.14  | n17= | 1.49700 | v17= | 81.6 |
| r32= | -28.420  | d31= | 4.00  | n18= | 1.80610 | v18= | 40.9 |
| r33= | -70.481  | d32= | 1.00  |      |         |      |      |
| r34= | 0.000    | d33= | 2.00  | n19= | 1.58913 | v19= | 61.1 |
| r35= | 0.000    | d34= | 20.00 | n20= | 1.51633 | v20= | 64.2 |
| r36= | 0.000    | d35= | 3.75  |      |         |      |      |

[0040]

### [External Character 5]

リアコンバーターレンズ

数値実施例3

|      |          |      |       |      |         |      |      |
|------|----------|------|-------|------|---------|------|------|
| r26= | 44.630   | d25= | 0.99  | n14= | 1.51633 | v14= | 64.2 |
| r27= | 11.717   | d26= | 1.20  |      |         |      |      |
| r28= | -124.402 | d27= | 1.72  | n15= | 1.69680 | v15= | 55.5 |
| r29= | 11.287   | d28= | 1.00  | n16= | 1.60342 | v16= | 38.0 |
| r30= | 94.748   | d29= | 4.30  |      |         |      |      |
| r31= | 13.733   | d30= | 1.50  | n17= | 1.48749 | v17= | 70.2 |
| r32= | -13.264  | d31= | 5.20  | n18= | 1.54814 | v18= | 45.8 |
| r33= | -159.824 | d32= | 1.20  |      |         |      |      |
| r34= | 0.000    | d33= | 2.00  | n19= | 1.58913 | v19= | 61.1 |
| r35= | 0.000    | d34= | 20.00 | n20= | 1.51633 | v20= | 64.2 |
| r36= | 0.000    | d35= | 3.75  |      |         |      |      |

[0041] The relation between a monograph affair type and many numeric values in a numerical example is shown in Table -1, and the item of the rear converter lens of each numerical example is shown in Table -2.

[0042]

[Table 1]

表 - 1

| 条件式 | 数 値 実 施 例 |       |       |
|-----|-----------|-------|-------|
|     | 1         | 2     | 3     |
| (1) | 0.038     | 0.031 | 0.016 |
| (2) | 29.3      | 40.7  | 24.4  |
| (3) | 3.30      | 3.30  | 3.30  |
| (4) | 0.039     | 0.062 | 0.094 |
| (5) | 1.546     | 1.550 | 1.546 |
| (6) | 1.733     | 1.733 | 1.587 |

[0043]

[Table 2]

表 - 2

|             | 数 値 実 施 例 |          |         |
|-------------|-----------|----------|---------|
|             | 1         | 2        | 3       |
| 焦点距離 $f_c$  | - 121.36  | - 101.37 | - 94.57 |
| マスターレンズとの間隔 | 0.98      | 1.71     | 0.99    |
| 拡大倍率        | 1.57x     | 1.60x    | 1.57x   |

[0044] Even when the rear converter lens of this operation gestalt secures the back focus which can arrange the prism for color separation to an image side and equips the about 1.6 - f number bright main lens system with it by set up a lens configuration appropriately while it secures the mechanical space of the mounting section for rear converter lens wearing though it is little easy and compact configuration of lens number of sheets , aberration fluctuation can demonstrate very little good optical character ability .

[0045]

[Effect of the Invention] The rear converter lens of good optical-character ability is realizable, securing a predetermined back focus according to this invention, though it is an easy configuration, as explained above.

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[Translation done.]